Barcelona Supercomputing Center
Centro Nacional de Supercomputación
EXCELENCIA SEVERO OCHOA

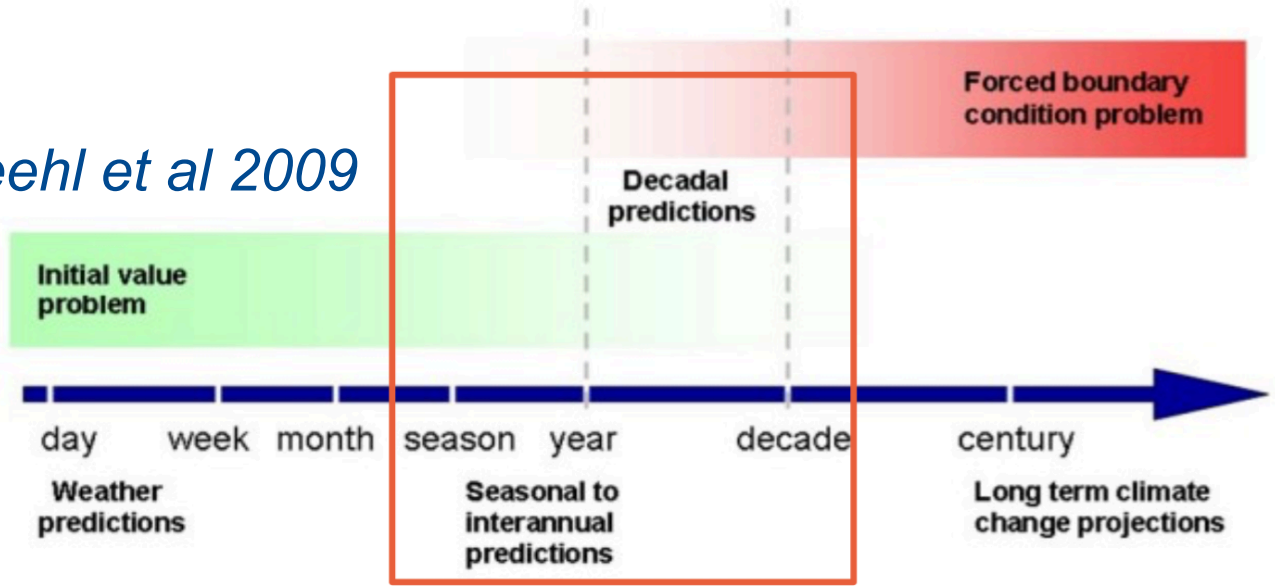
Ongoing activities of the Climate Prediction Group at BSC

J Acosta, T Arsouze, R Bernardello, R Bilbao, LP Caron, R. Cruz-García, E Exarchou, V Guemas, J García-Serrano, M Menegoz, B Mezzina, P Ortega, F Palmeiro, J Ruprich-Robert, V Sicardi, E Tourigny

(pablo.ortega@bsc.es)

Cornerstones of climate prediction

Meehl et al 2009



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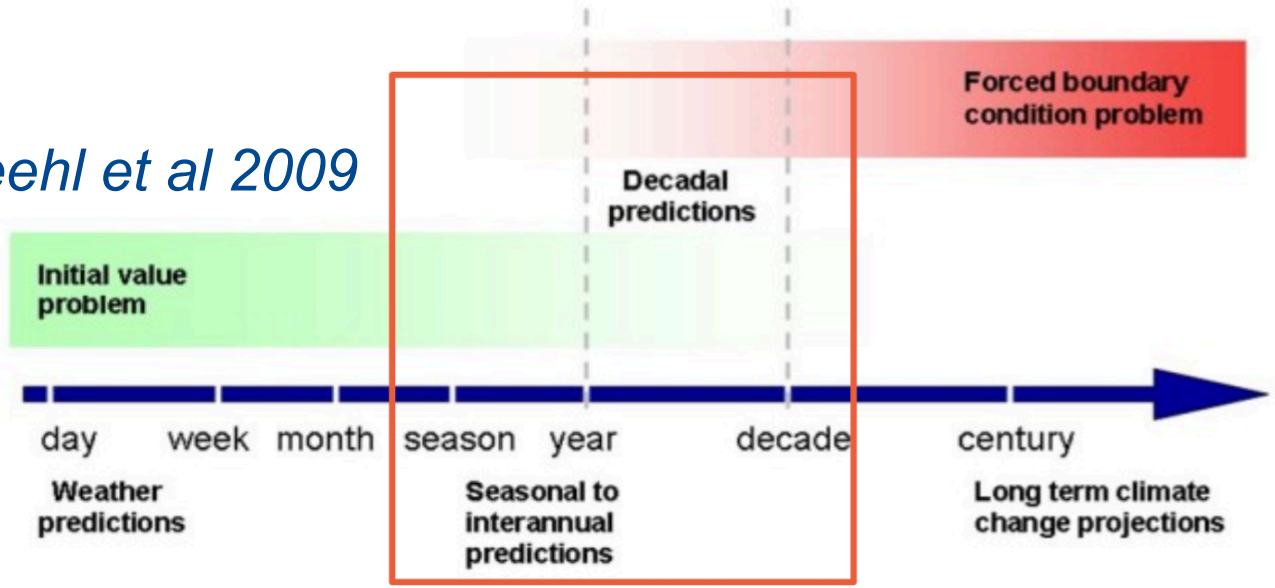

Scientific questions

1) Role of forcings?

2) Internal sources of predictability?

3) Predictability of the different components?

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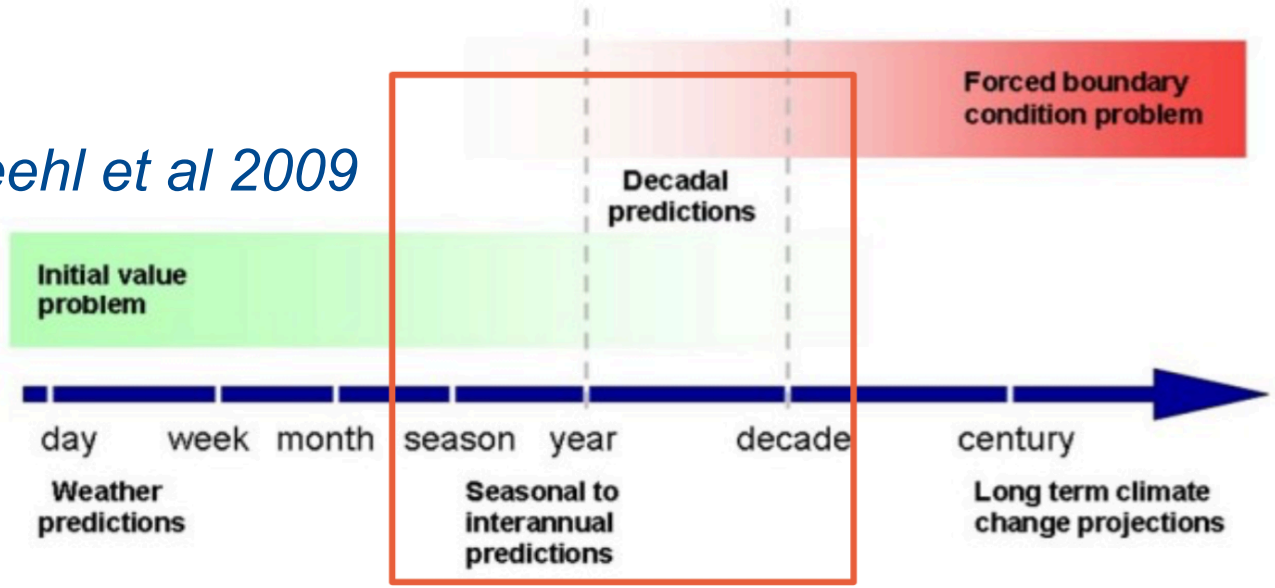

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Predictability from volcanic eruptions

M. Ménégoz
(martin.menegoz@bsc.es)

R. Bilbao
(roberto.bilbao@bsc.es)

Vol Forcing - Initialized
Ideal Vol For. 1 - Initialized
Ideal Vol For. 2 - Initialized
No Vol For. - Initialized
Vol Forcing - No Init

Decadal Hindcasts
[1961-2001]

Major Eruptions:

Agung (1963)
El Chichón (1982)
Pinatubo (1991)

Predictability from volcanic eruptions

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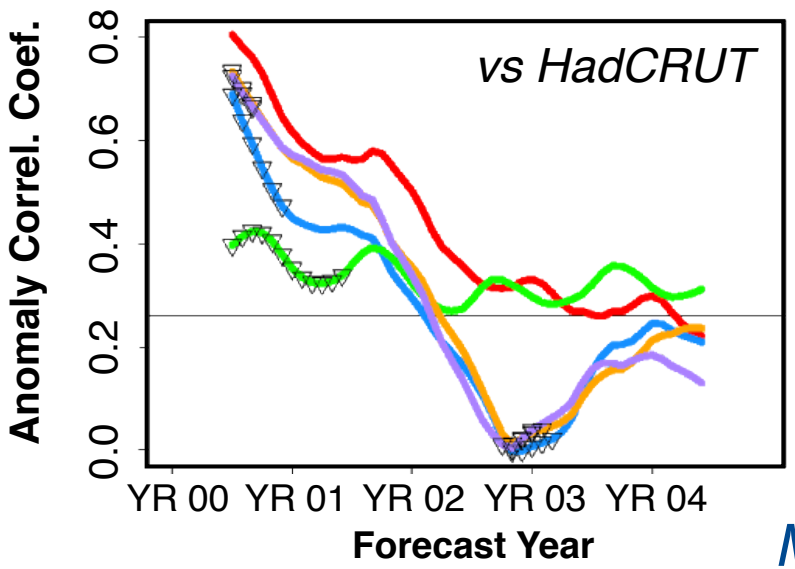
Skill in mean global surface temperature



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Decadal Hindcasts
[1961-2001]

Major Eruptions:

Agung (1963)
El Chichón (1982)
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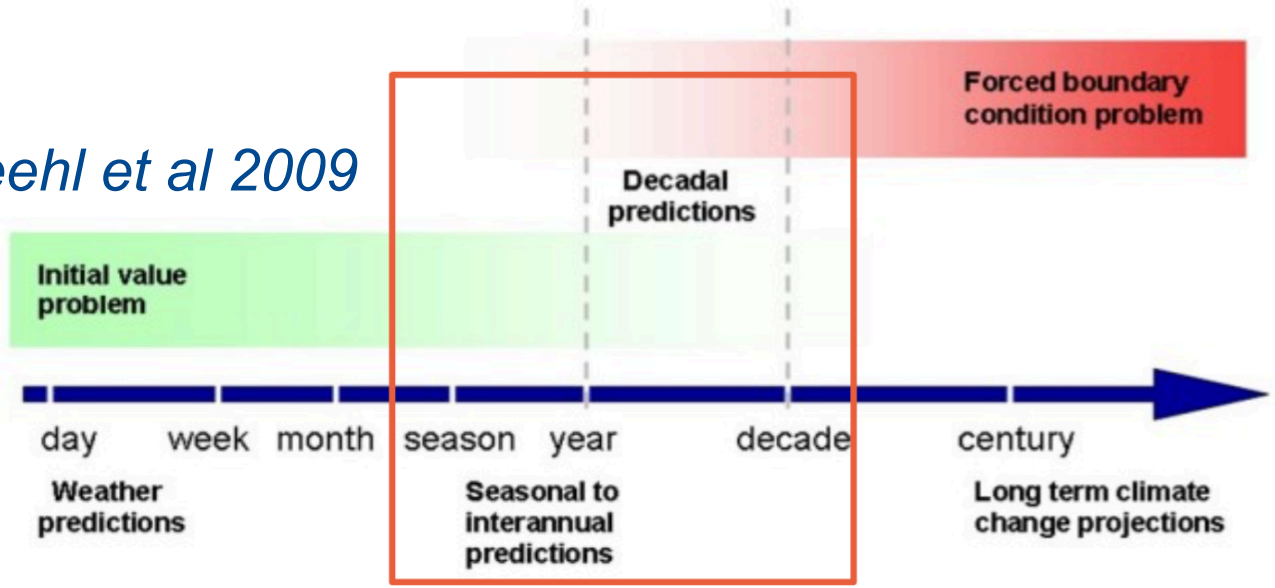
Menegoz et al 2018

Volcanic eruptions can provide skill in mean global surface temperature for up to 2 years

Cornerstones of climate prediction

Meehl et al 2009



Scientific questions

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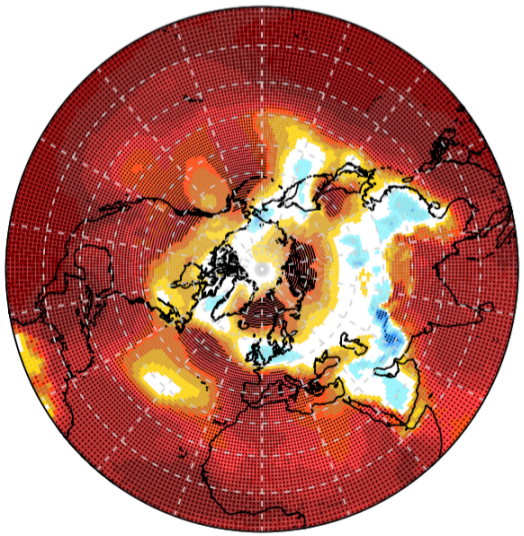
Predictability from Sea Ice

J. Acosta
(juan.acosta@bsc.es)

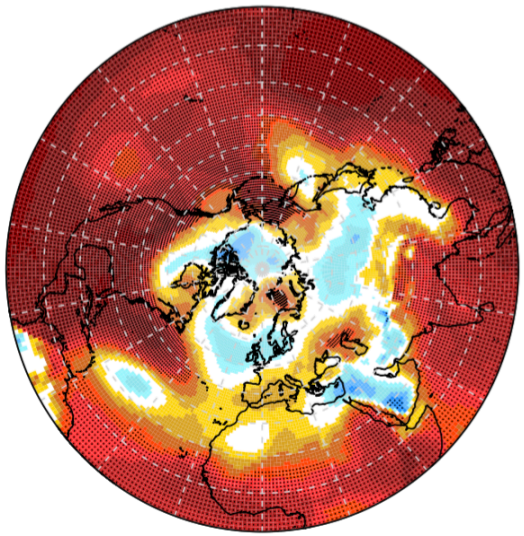
Seasonal Hindcasts with EC-Earth v3.2.2 [1993-2014]

Impact of Sea Ice initialization on Surface Temperature in DJF

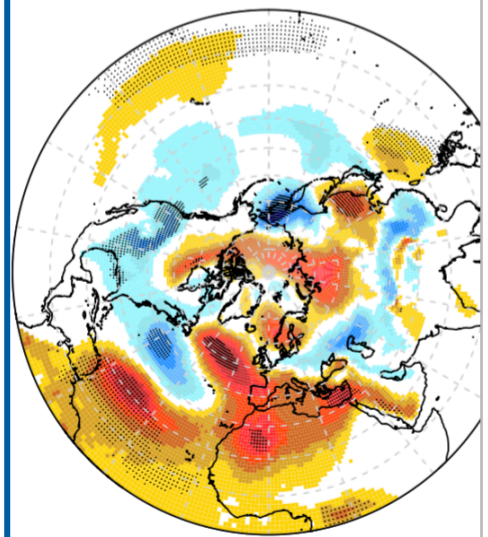
Sea Ice Assimilation (EnKF)

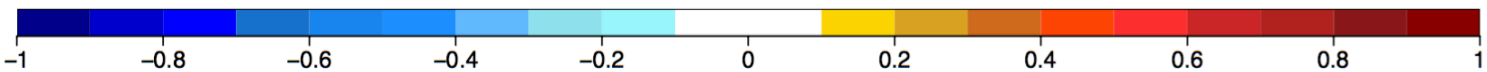


Sea Ice Reconstruction (Ocean nudging)



Difference in Skill





A better sea-ice initialization can improve the skill in the Mediterranean area and Scandinavia

Predictability from Sea Ice

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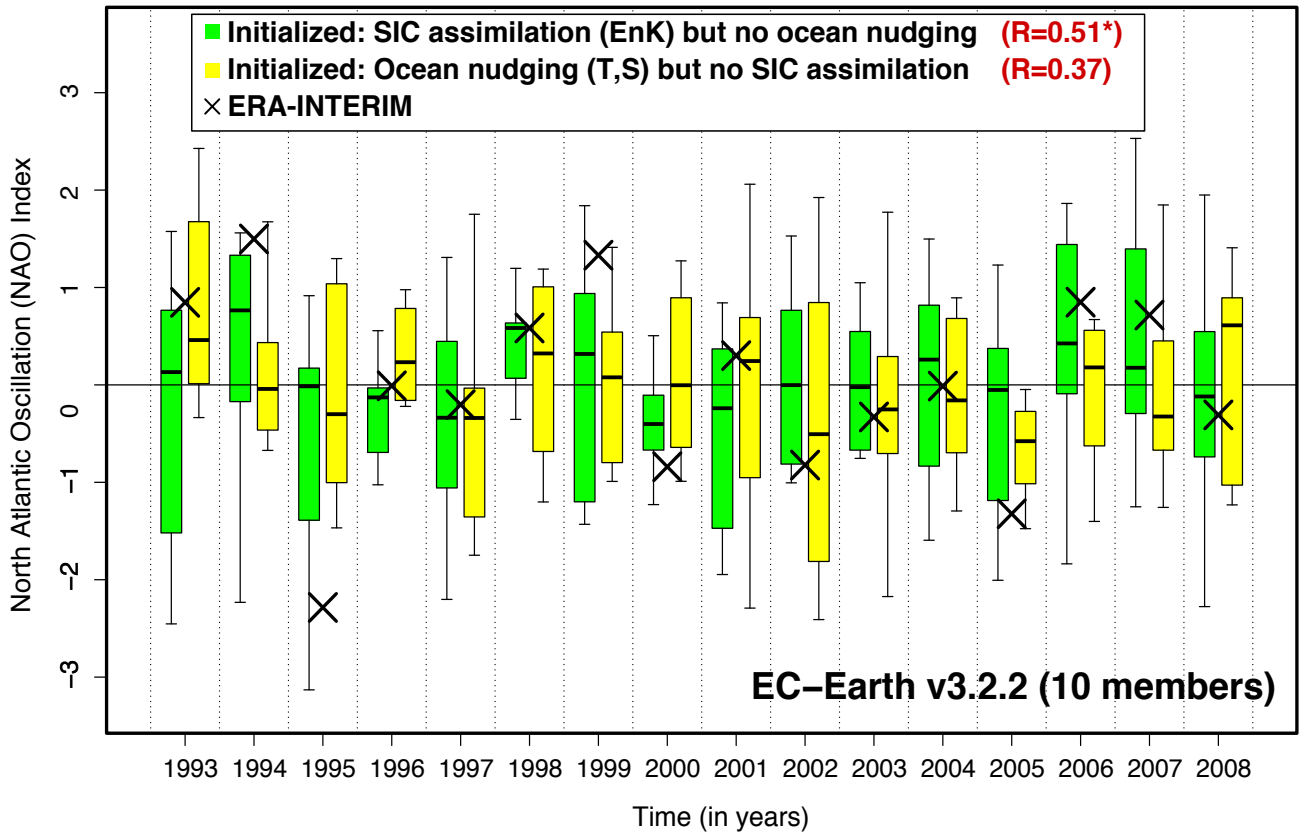
Seasonal Hindcasts with EC-Earth v3.2.2 [1993-2014]

Impact of Sea Ice initialization on NAO skill

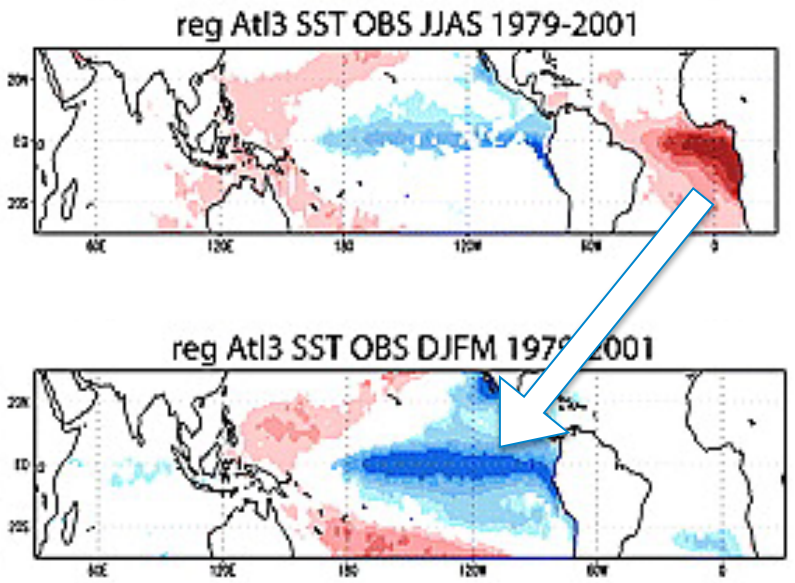


This improvement could potentially come from enhanced skill in the NAO

Predictability of tropical teleconnections

E. Exarchou
(eleftheria.exarchou@bsc.es)

Observed teleconnection of Atlantic Niño with winter NIÑO



Rodriguez-Fonseca et al 2009

Predictability of tropical teleconnections

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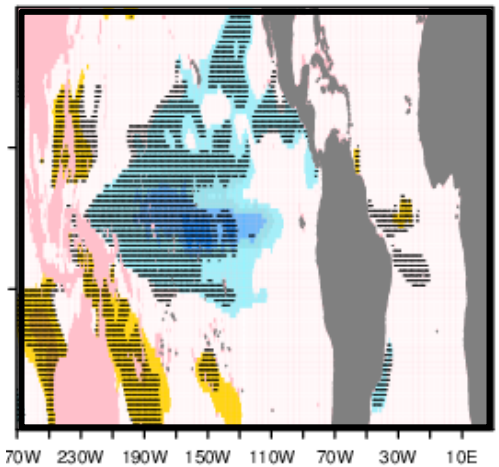
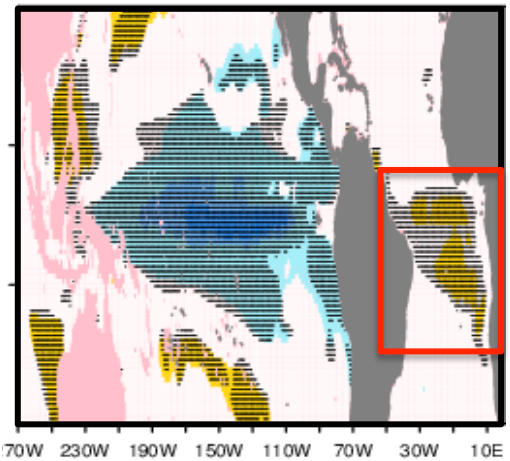
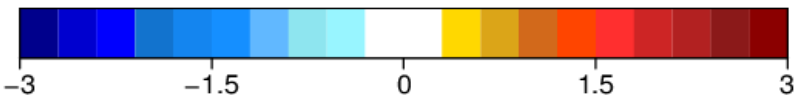
Regression JJA ATL3 vs OND T2M

Control

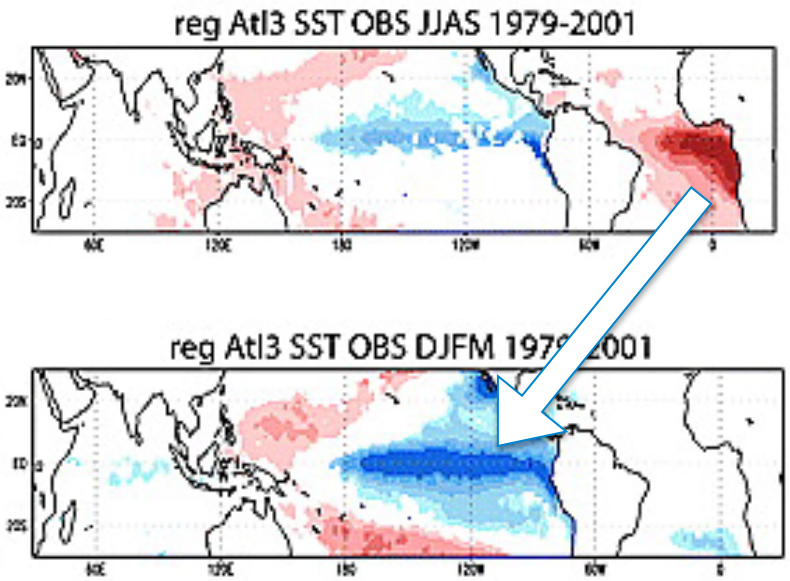


Wind forced in TA
(to correct the bias)





Observed teleconnection
Atlantic Niño with winter NIÑO



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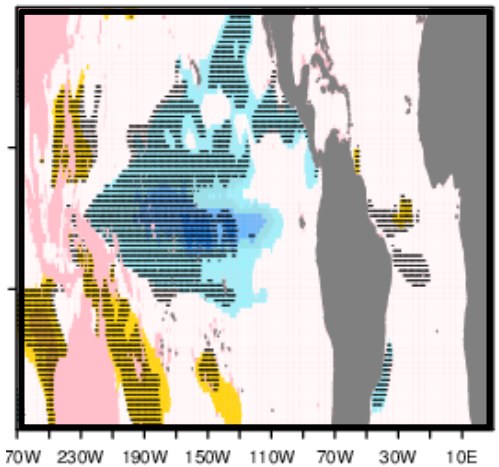

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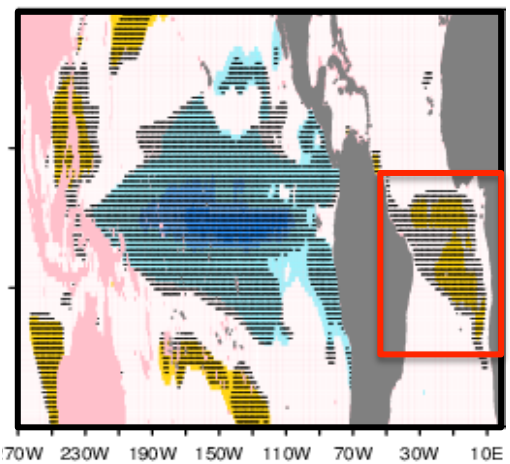
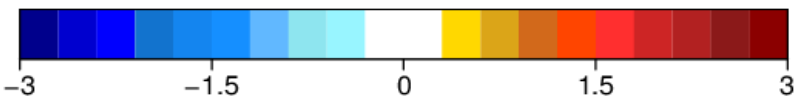
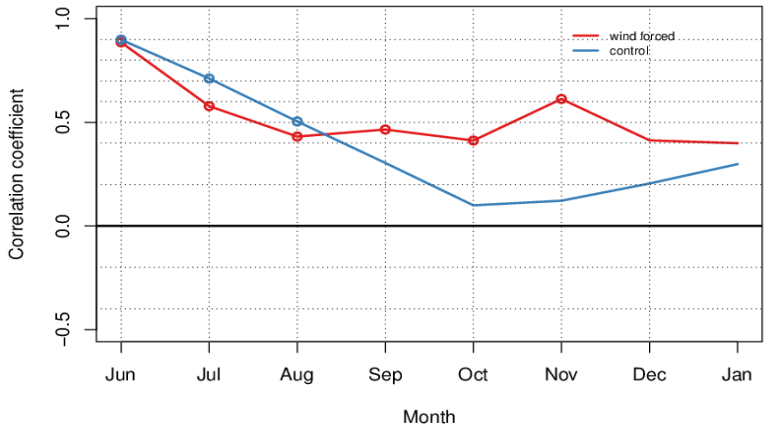
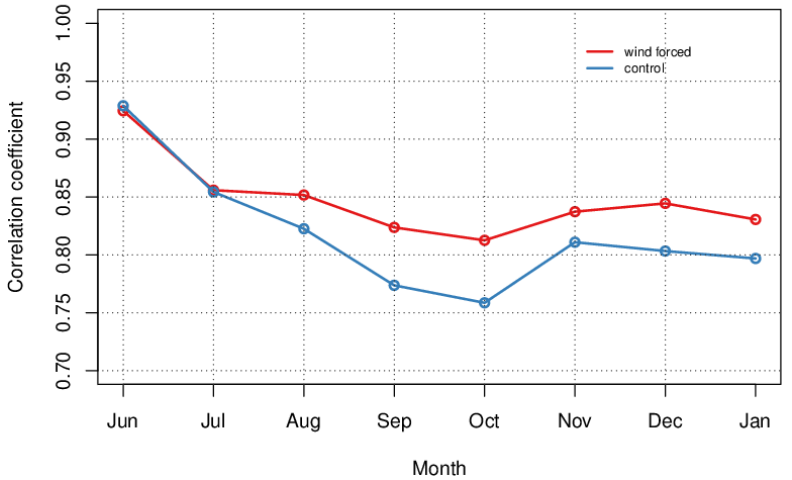




Skill in ATL3 (1980-2009)



Skill in NIÑO3 (1980-2009)

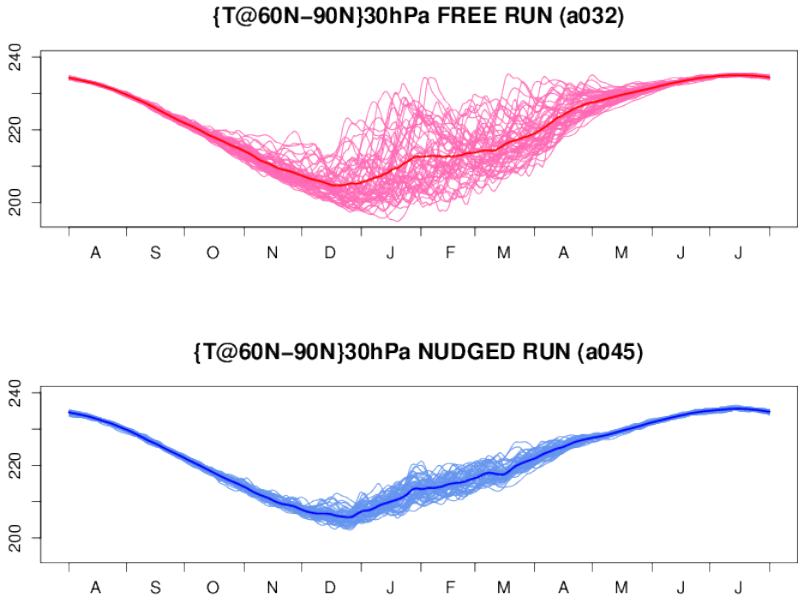


A realistic representation of TA variability helps to improve the skill in el NIÑO3 region

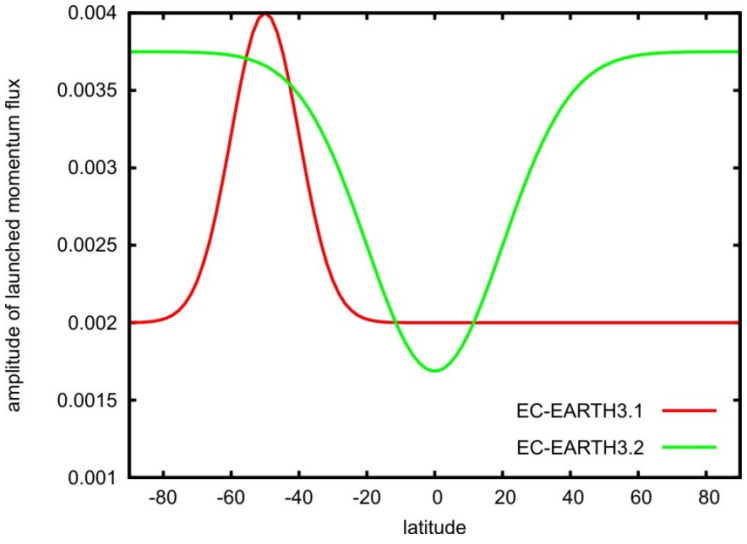
Predictability from the stratosphere

J. García-Serrano
(javier.garcia@bsc.es)

NAO/AO dynamics
+ atmospheric nudging

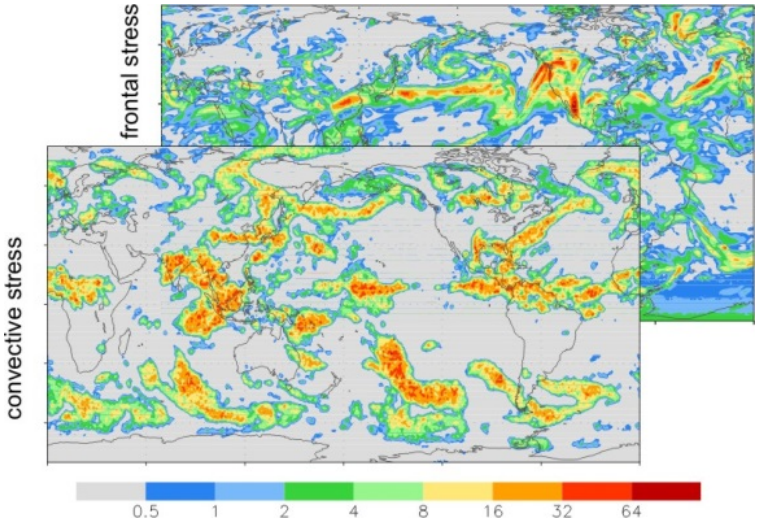


current NGWs (source-unrelated)



SIDIS

future NGWs (linked to dynamics)



Applications of Ocean nudging

V. Sicardi
(valentina.sicardi@bsc.es)

- Initial Conditions
- Reconstructions: (e.g. AMOC/ Sea Ice/ Biogeochemistry)
- Pacemaker experiments (DCPP/Component C)

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Surface nudging

1) Both in SSS and SST
2) Only in SSS
3) Only in SST

No Equatorial band
Possible for specific basins

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Surface nudging

1) Both in SSS and SST
2) Only in SSS
3) Only in SST

No Equatorial band
Possible for specific basins

3D nudging
(below mixed layer depth)

1) Both in Salinity and Temperature
2) Only in Salinity
3) Only in Temperature

Globally
Specific basins under development

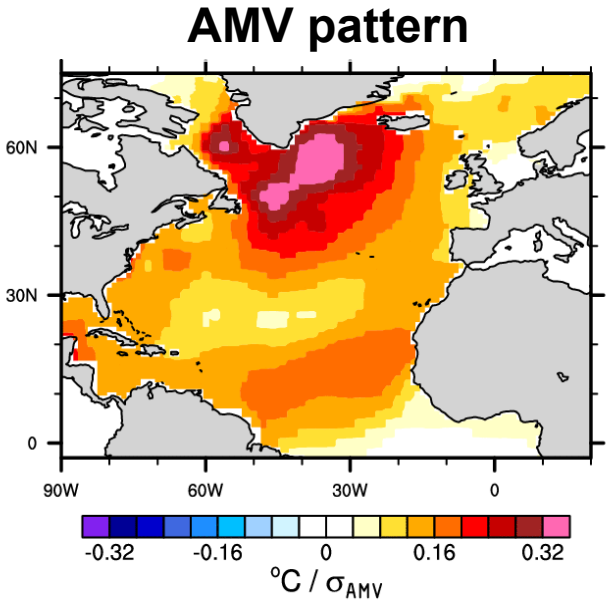
WIKI - Guidelines for the use of ocean nudging in EC-Earth3:
https://dev.ec-earth.org/projects/ecearth3/wiki/NEMO_ocean_nudging

Example of Pacemaker experiment

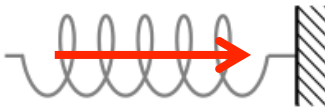
Y. Ruprich-Robert
(yohan.ruprich@bsc.es)

Identifying the climate impacts of AMV

- NA SSTs restored to **observed AMV pattern**
- **15-day** restoring time scale
- **10-yr** long **large ensemble** (> 25 members)



AMV+ : daily North Atlantic SST  daily Climatology **+ AMV pattern**

AMV- : daily North Atlantic SST  daily Climatology **- AMV pattern**

CMIP6 DCPP component C protocol (Boer et al. GMD 2016)

Other DCPP and prediction Experiments

Component C - Idealized impact of AMV experiments
(R. Bilbao, Y. Ruprich-Roberts)

Component C - Volcano effects on decadal - prediction
(M. Menegoz)

Component A + PISCES for ocean CO2 uptake
(V. Sicardi, R. Bernardello)

Predictability of ocean biogeochemistry

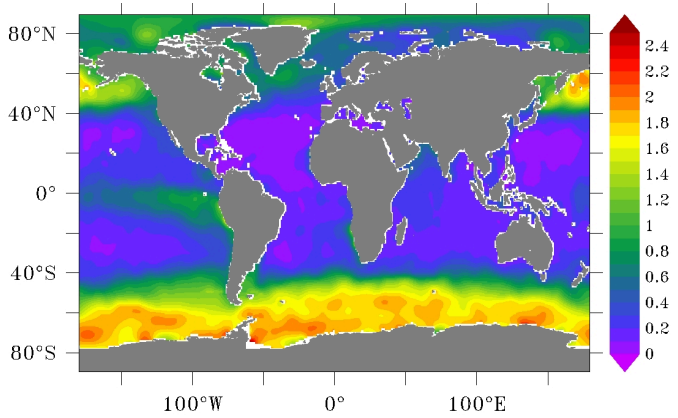
R. Bernardello
(raffaele.bernardello@bsc.es)

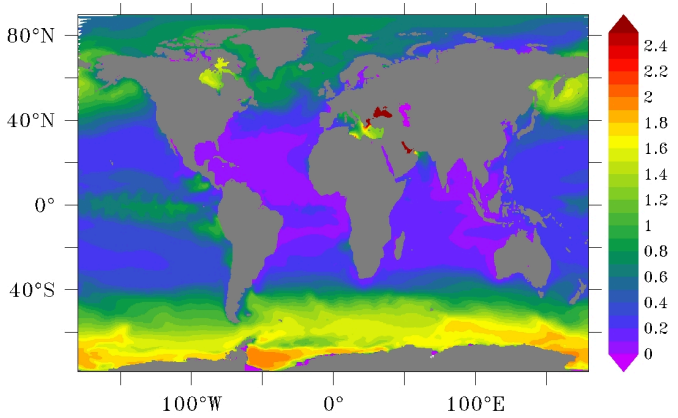
V. Sicardi
(valentina.sicardi@bsc.es)

1st phase: generation of ocean biogeochemical ICs → Dynamical forcing ocean-only run (1984 DFS5.2)

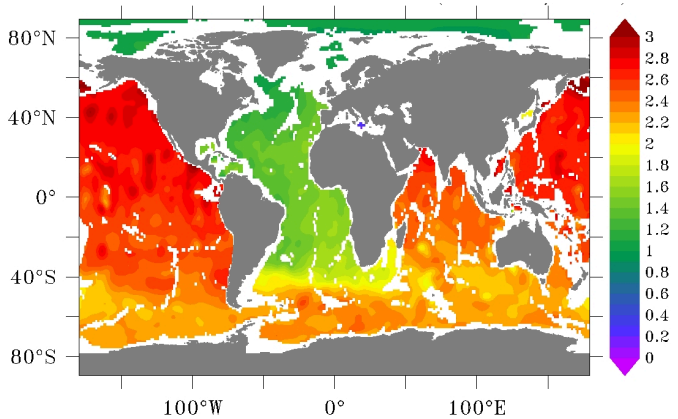
Observations (WOA13) | PISCES offline (year **2400**)

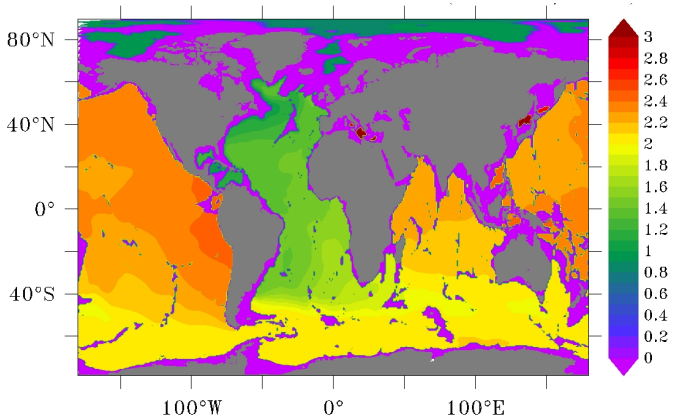
5 m





3000 m





Phosphate (mmol/m^3)

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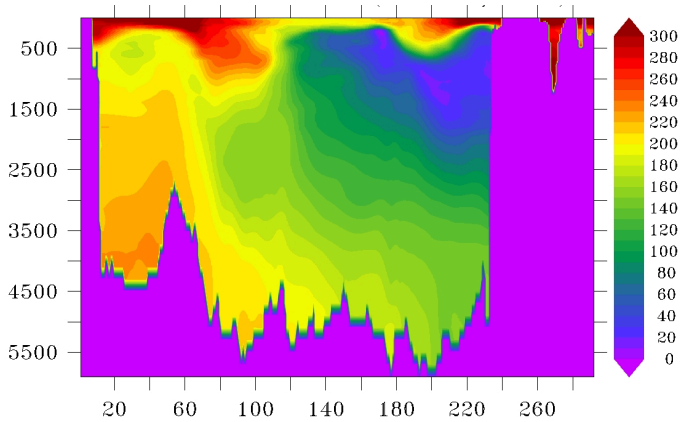
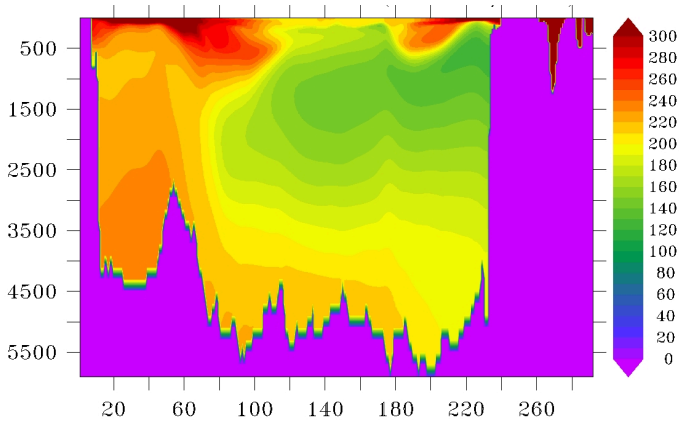
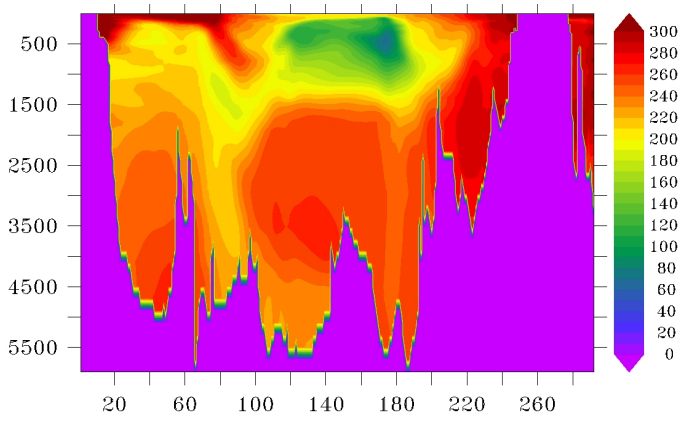
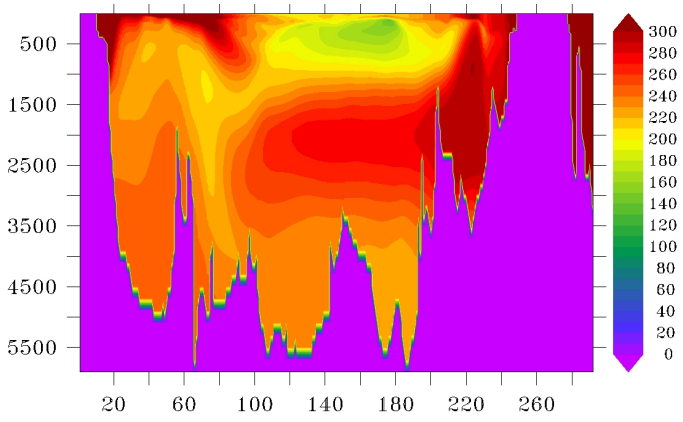
Pacific O.





Atlantic O.





Oxygen (mmol/m^3)

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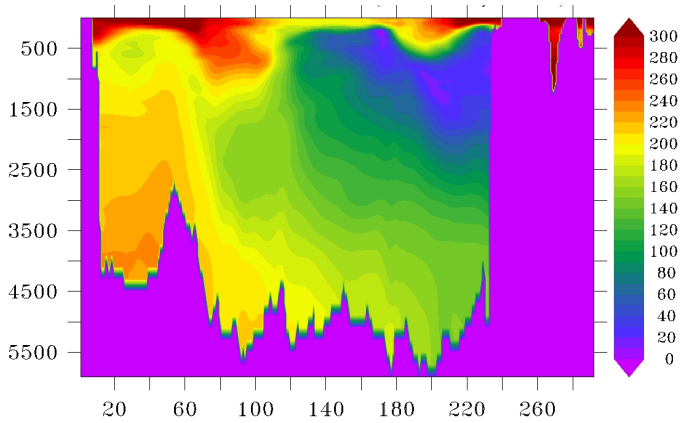
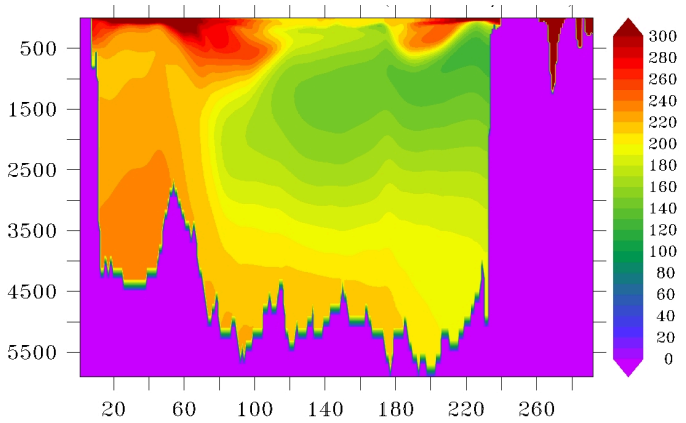
Pacific O.

Observations (WOA13)



PISCES offline (year **2400**)



1. Start a BGQ reconstruction with PISCES online
2. DCPP Component A/B-like decadal predictions [1982 – Present]

Special Focus: on Southern Ocean carbon uptake

Other DCPP and prediction Experiments

Component C - Idealized impact of AMV experiments (R. Bilbao, Y. Ruprich-Roberts)

Component C - Volcano effects on decadal - prediction (M. Menegoz)

Component A + PISCES for ocean CO2 uptake (V. Sicardi, R. Bernardello)

Decadal prediction of fire risk (E. Tourigny)

- Using LPJ-Guess offline script in ESM branch (ece-lsm.sh)
- Decadal predictions initialized on Jan 1st for each year
- Using daily IFS outputs from DCPP runs (temp, precip, etc.)
- Need to produce LPJ-Guess ICs from ERA reanalyses